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The macroeconomic impact of road construction in rural areas of South Africa

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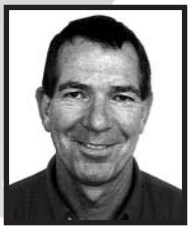

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Keywords: road construction, macroeconomic impact, poverty alleviation, labour intensive, rural areas

This paper examines the macroeconomic impact of labour-based road construction in rural, underdeveloped areas. The macroeconomic effect is measured by the contribution to gross domestic product (GDP), number of indirect jobs created nationally, contribution to taxes and contribution to indirect household income for each of eleven rural road construction projects.

The paper has two objectives. The first is to determine the overall multiplied impact of road construction in rural underdeveloped areas in South Africa. The second is to determine the macroeconomic impact of marginal changes in the use of labour and plant in road construction.

Input-output analysis was used to analyse a total of eleven projects. It was found that the GDP multiplier ranged between 1,34 and 1,53 with an average of 1,45. The cost of creating an indirect job ranged from R95 250 to R145 972 with an average cost of R113 835.

The effect of substituting labour for plant in the construction methods is examined by means of sensitivity analysis. The sensitivity analysis shows that as the proportion of labour increases relative to plant so the macroeconomic benefits increase and therefore by implication poverty alleviation.

INTRODUCTION

With the high unemployment rate in South Africa job creation is the focus of current government policy. Job summits, such as the Presidential Jobs Summit in 1998 and the Growth and Development Summit held at the beginning of 2003, highlight the importance of job creation and poverty alleviation.

This paper examines the macroeconomic impact of constructing roads in underdeveloped, rural areas. Road construction serves to alleviate poverty in a two-pronged approach. First, roads serve as a platform on which further infrastructural and economic development can take place. They open up access to markets for agricultural produce, allow access for tourism and other forms of industry thereby stimulating the local economy. Second, by making use of the local resources, some of the funds directly stimulate the local economy.

The paper has two objectives. The first is to determine the overall multiplied impact of road construction in rural underdeveloped areas in South Africa. The second is to determine the macroeconomic impact of marginal changes in the use of labour and plant in road construction. Only the road contract is investigated and not additional project costs such as professional fees. The overall aim of the investigation is to determine the value of the contract that is paid to labour, as well as to determine the impact of marginal changes in labour content.

The paper begins with a brief literature review and goes on to describe the methodology used and the results of the economic impact of eleven road construction projects in South Africa.

The literature indicates that roads are an integral part of the infrastructure that is necessary for economic growth. Labour-intensive works are particularly attractive as a vehicle for developing local contracting industries and furthering skills development. When the fundamentals are in place the use of labour-intensive construction will benefit the community and lead to poverty alleviation (Edmonds 1998, Smith 1982, Stilwell & Atkinson 1999).

While road construction is an essential element in poverty alleviation programmes, it cannot create sustainable improvement on its own. It needs to form part of a comprehensive suite of infrastructural development programmes. Follow-up programmes to sustain the skills and developments generated by road construction are thus very important. From the 1999/2000 Baseline Community Involvement Report (Jennings & Smith 2001) it does seem apparent that rural development programmes do incorporate road construction along with many other projects and do not stop at only developing the roads. The programme goes on to include projects such as housing, provision of schools and health clinics, water reticulation and electrification.

This paper, which only concentrates on the macroeconomic impact of the road construction, was developed from broader research that included an investigation into the public works programmes. The broader

Table 1 Example of decomposing a sub-section of the bill of quantities into SIC categories

Description	Unit	Scheduled quantity	Rate	Amount	SIC code	%	Amount
SECTION 1200 – GENERAL REQUIREMENTS & PROVISIONS							
Provisional sums allowed for:							
(a) Exhumation of graves	Sum	1	R50 000	R50 000	1 8330	80 % 20 %	R40 000 R10 000
(b) Relocation of houses	Sum	1	R100 000	R100 000	1 7100 8300	3 % 40 % 57 %	R3 000 R40 000 R57 000
Project liaison officer							
(a) Remuneration	Sum	1	R150 000	R150 000	2	100 %	R150 000

research investigated the types of follow up programmes that supplement the skills learnt from the road construction. Other issues, such as social pride, cannot be quantified but are also an important part of labour-intensive infrastructural development programmes.

IMPACT OF ROAD CONSTRUCTION ON REGIONAL ECONOMIES

The economic effect of investment in transport infrastructure occurs in several phases. During the construction phase, expenditure on goods and services will have a multiplier effect and add to the national income by increasing the average per capita income. The multiplier effect continues while the expenditure is being incurred and for some time afterwards but will eventually disappear and national income will revert to its former level (Floor *et al* 1993).

Clearly road construction is important not only because of the income impacts during construction but also because of the developmental consequences of giving isolated rural areas easier access to markets, health services, etc.

Labour-intensive road construction

In a Department of Transport report (1998), conclusions were drawn on various construction projects undertaken in developing nations. The main conclusions were that labour-intensive work methods are technically and financially feasible for certain types of work. Strong and sustained commitment of government to cost-effective use of skilled labour and adequate institutional support are prerequisites for a successful execution of such projects or programs. While creating assets for the economy at large, labour-intensive technologies contribute, at the same time, to the alleviation of poverty, the generation of employment, and the saving of foreign exchange (Department of Transport 1998).

Macroeconomic impacts

While there are a number of different types of macroeconomic effects, the two most important are contribution to GDP and creation of jobs. The importance of job creation is obvious. Increases in GDP are synonymous with increases in people's economic standards of living. Increased GDP – that is, increased production – is experienced in the form of more jobs, higher wages and reduced economic hardship. It is clearly an important measure.

It is well recognised that the simple act of spending – construction of a road, for example – leads to other economic effects. Demand for steel and cement can lead to increased production in those industries. Increased demand for steel and cement, in turn, leads to increased demand for mining output which uses wood, water, electricity and so on. These are the multiplier effects.

While this process unfolds, each industry employs people and pays wages. Employees, in turn, spend their wages and cause further multiplier effects through the economy. Measuring this is further complicated by the fact that different industries demand different types of skills. This leads to different wage structures across the various industries. People earning different wages have different spending patterns. Thus the change in overall spending patterns is dependent on which industries are affected.

The general formulation for the multiplier effect is (Black, Hartzenberg & Standish 2000):

$$M = \frac{1}{1 - MPC\ (1 - MPT) + MPI\ (1 - MPT)}$$

where M = the regional (district, provincial or national) multiplier

MPC = the marginal propensity of the region to consume

MPI = the marginal propensity of the region to import

MPT = the marginal propensity to tax

To estimate or calculate the multiplier effect of the investment in road projects, it is necessary to take into account the marginal propensity to consume; the propensity to import and the propensity to tax. The higher the propensity to import goods and materials the lower the expenditure in the region to which the multiplier applies. For road projects it is normal to find that the district multiplier is lower than the provincial or national multipliers because of the 'openness' of the district and the ease through which the factors of production can move across its borders.

METHODOLOGY

Input-output analysis was used for the measurement of the macroeconomic impact of upgrading the roads. This approach demands that all expenditure in and around the roads be identified and estimated. This expenditure, in turn, needs to be linked to the standard industrial classification of all economic activity (SIC codes). In addition, if employment is part of the expenditure then estimates must be made of the likely items of expenditure as a result of wage payments. Allowances must also be made for the fact that workers at different income levels have different spending patterns.

Five steps are required to measure the overall economic impact of road upgrading or construction:

- First, to identify an appropriate bill of quantities. Eleven such bills were accessed.
- Second, to determine the relative proportions of profit, labour, plant and material for each line item in the bill of quantities.
- Third, to assign each item of material and plant in the bill of quantities to the appropriate SIC code.
- Fourth, to decompose labour and profit into income categories and apportion the total wages and profits to each income category. Following this, estimates of expenditure patterns by income category are used to deter-

Table 2 Cost components of reinforced concrete items

Material	Component	Cost	%	SIC code
Concrete:	Cement	R220/m^3	30,56	3692
	Aggregate	R145/m^3	20,14	3699
	Mixing labour	R20/m^3	2,78	1
	Placing labour	R15/m^3	2,08	1
Reinforcing steel:	Steel @ 80 kg/m^3	R256/m^3	35,56	3710
	Fixing labour	R64/m^3	8,89	1
Total		**R720/m^3**	**100,00**	

Table 3 Decomposition of fixed and value-related preliminary and general items

Component	%	SIC code
Civil engineering and other construction	30	5200
Business services	30	8320
Machinery and equipment renting and leasing	20	8330
Other services, profit seeking	20	9700

Table 4 Cost breakdown of time-related preliminary and general items

Item	Amount	%	SIC code
General labour and security watchmen	R20 000	9,09	1
Ten leading hands @ R5 000/month	R50 000	22,73	2
Three section foremen @ R15 000/ month	R45 000	20,45	3
One site agent @ R25 000/month	R25 000	11,36	4
Sub-total (salaries)	**R140 000**	**63,64**	
Civil engineering and other construction	30 % x R80 000	10,91	5200
Business services	30 % x R80 000	10,91	8320
Machinery and equipment renting and leasing	20 % x R80 000	7,27	8330
Other services, profit seeking	20 % x R80 000	7,27	9700
Sub-total (difference between total and salaries)	**R80 000**	**36,36**	
Total (given in bill of quantities)	**R220 000**	**100,00**	

Table 5 List of projects

Project no	Contract value (ex VAT) (current prices)	District and province	Year
1	R59 000 000	Lusikisiki, Eastern Cape	2001
2	R875 910	Qumbu, Eastern Cape	1999
3	R1 585 642	Ceres, Western Cape	2000
4	R2 488 524	Beaufort West, Western Cape	2000
5	R3 161 892	Uniondale, Western Cape	2000
6	R1 939 258	Heidelberg, Western Cape	2000
7	R1 841 875	Vredendal, Western Cape	2000
8	R1 296 133	Umtata, Eastern Cape	2000
9	R1 322 721	Lusikisiki, Eastern Cape	2000
10	R1 217 845	Lusikisiki, Eastern Cape	2000
11	R683 960	Elliotdale, Eastern Cape	2001

mine total spending patterns. These spending patterns were sourced from Standish (2003).

- Finally, all the items in the SIC coded bill of quantities are brought together. The total multiplier effect is calculated as the aggregate product SIC coded spending on plant and material, as well as SIC-coded spending by workers multiplied through the national multipliers. The national multipliers are known through the South African input output tables (Statistics South Africa 1993).

Decomposition of selected items

Selected items from the bill of quantities were aligned with the relevant SIC codes. Calculations were performed for many of these items to determine the composition of the rates. These calculations were verified by a practising quantity surveyor.

General requirements

An example of the breakdown of the 'general requirements' subsection from the bill of quantities is shown in table 1 on page 15.

Composition of reinforced concrete

The composition of reinforced concrete is treated as shown in table 2 (page 15).

Preliminary and general items

Preliminary and general items were not given in any detail in the bills of quantities that were made available yet these items constitute about 15 % to 20 % of a typical road contract. This item was investigated more intensively and can be described as either 'fixed and value related items' or 'time related items':

- *Fixed and value related items:* These items include spending on insurances, bank guarantees, the setting up of site accommodation and offices for the site personnel as well as renting or purchasing of plant. The breakdown that was used is given in table 3.
- *Time-related items:* Salaries for key personnel and items paid on a monthly basis are part of this category. This includes security and any goodwill money paid to local leaders for the right to use their land during construction. Table 4, which is based on typical salaries and number of personnel employed on a site, shows the composition that was used for time related items.

MACROECONOMIC IMPACT OF THE PROJECTS

As mentioned above, eleven road projects were made available for the purposes of this research. The location and cost of these projects are given in table 5.

The contract values in table 5 are the current prices at the time the roads were built. In the rest of this paper the prices have been changed to 2003 values in order to allow comparison between projects. All the projects were either upgrading or resurfacing existing roads. The lengths of the roads varied from 766 m to 17 km.

Most of the bills of quantities were as-built bills. In some cases, the bills were estimates of what the road construction rates and prices should be. In these cases, the contingency and contract price adjustment items were spread pro rata across the rest of the bill.

Table 6 summarises the number of indirect jobs created, the amount spent per indirect job created for each project, the national multiplier, contribution to taxes, the indirect taxes as a percentage of the budget, the contribution to indirect household income and this household income as a percentage of the budget. It is important to note that indirect jobs are not the direct jobs created on site but rather the indirect jobs created through the multiplier effects in the economy.

The number of indirect jobs created by the different projects varies greatly because of the large difference in project budgets. A better indicator of indirect job creation is the amount of money spent per indirect job created. The lowest amount spent to create an indirect job was R95 250 for project 5, while the most spent to create an indirect job was R145 972 for project 2. Project 5 had the second highest budget (R3,16 million), while project 2 had the second lowest budget (approximately R876 000). The average across all 11 projects was R113 835 per indirect job.

The national multiplier figures vary from 1,34 to 1,53, with an average of 1,45. These figures compare reasonably well to a study by Naudé on the Huguenot Tunnel outside Paarl, where the multiplier was calculated to be between 1,57 and 2,74 (Naudé 1983).

When comparing the contribution to taxes and contribution to indirect household income, it is better to look at their proportions of the project budget rather than the absolute values.

The projects generated taxes to the value of between 12,9 % and 22,6 % of the contract value, with an average of 18,4 %. The projects generated indirect household income to the amount of between 38,8 %

Table 6 Economic output for road projects

Project no	Indirect jobs	R spend per indirect job	National multiplier	Contribution to indirect taxes	Indirect tax as % of budget	Indirect h/hold inc	Indirect h/hold inc as % of budget
1	663	R105 719	1,45	R12 085 145	17,2	R34 741 943	**49,6**
2	8	R145 972	1,34	R151 154	12,9	R452 584	**38,8**
3	18	R111 455	1,48	R407 548	20,3	R953 652	**47,5**
4	33	R95 409	1,51	R646 152	20,5	R1 719 626	**54,6**
5	42	R95 250	1,53	R872 856	21,8	R2 194 021	**54,8**
6	24	R102 233	1,53	R553 290	22,6	R1 221 401	**49,8**
7	21	R110 970	1,47	R494 975	21,2	R1 160 536	**49,8**
8	16	R102 494	1,44	R242 038	14,8	R867 891	**52,9**
9	13	R128 733	1,40	R260 001	15,5	R726 254	**43,4**
10	13	R118 527	1,42	R248 493	16,1	R700 825	**45,5**
11	6	R135 424	1,44	R138 495	19,4	R362 353	**50,8**

Table 7 Distribution of salaries and wages out of contract price among labour categories

Project no	<40k	40k – 100k	100k – 200k	>200k	Total salaries in contract
1	13,3 %	4,1 %	3,4 %	1,6 %	22,5 %
2	13,7 %	1,8 %	0,6 %	0,3 %	16,4 %
3	22,8 %	3,1 %	2,8 %	1,3 %	30,0 %
4	19,9 %	3,2 %	2,9 %	1,4 %	27,4 %
5	19,2 %	4,6 %	4,2 %	2,0 %	29,8 %
6	29,6 %	2,7 %	2,5 %	1,2 %	35,9 %
7	12,7 %	7,0 %	6,4 %	3,0 %	29,1 %
8	15,1 %	0,1 %	0,0 %	0,0 %	15,2 %
9	11,7 %	3,8 %	3,0 %	1,4 %	20,0 %
10	15,0 %	3,1 %	2,5 %	1,2 %	21,8 %
11	15,3 %	4,3 %	3,4 %	1,6 %	24,7 %

Table 8 Effect of labour substitution on the GDP multiplier

	Plant intensive	Base case	Labour intensive
Average multiplier	1,445	1,454	1,492
% Change	–0,6 %	–	2,6 %
Total wage bill	R22 670 082	R24 205 766	R28 833 920
% Change	–6,3 %	–	19,1 %

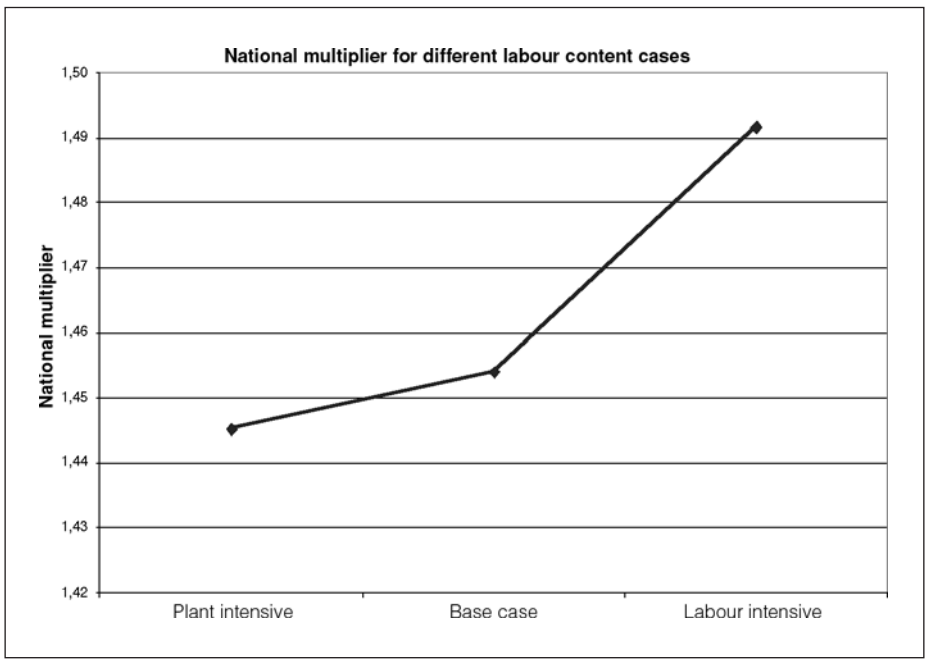

Figure 1 GDP multiplier for different labour payments

and 54,8 % of the contract value, with an average of 48,9 %.

Table 7 shows the distribution of the salaries and wages paid to the four labour categories. It can be seen that the majority of the salaries and wages for the road contract is paid to the lowest income category (those earning less than R40 000 per annum). It should be noted that these are only the amounts paid out in salaries and wages to the labour on site and do not include professional fees or profit.

The proportion of the contract paid out in salaries and wages varies from 15,2 % for project 8 to 35,9 % for project 6. The reason for the large variation in amounts paid out in salaries and wages is the variation in the amount of labour-intensive versus plant intensive work performed on each contract and different complexities encountered in each project.

MACROECONOMIC IMPACT OF VARIATIONS IN THE USE OF LABOUR AND PLANT

In poverty alleviation programmes, labour-intensive construction is required to ensure that funds find their way into the local community and in so doing provide a stimulus for the local economy. This section looks at the macroeconomic impact of marginal substitution of labour for plant by performing a sensitivity analysis on the labour/plant composition in the bills of quantities.

In the base case (all the projects and results in the report so far) the initial split for the plant-intensive items is 5 % labour (operator) and 95 % plant. The split in cost for the more labour-intensive items is 20 % labour and 80 % plant. Examples of the more plant-intensive items include excavation in hard material, hauling material over distances in excess of 1 km, crushing stone and erecting concrete panels. Such activities require the use of heavy machinery and an operator. Examples of the more labour-intensive items are excavation in soft material; hauling material over distances less than 1 km, backfill and light compaction

Table 9 Effect of labour substitution on number of indirect jobs created

	Plant intensive	Base case	Labour intensive
Total indirect jobs	848	857	887
% Change	–1,1 %	–	3,5 %
Cost to create an indirect job	R121 614	R120 337	R116 267
% Change	1,1%	–	–3,4%

Table 10 Effect of labour substitution on contribution to taxes

Project no	Base case	Plant intensive	Labour intensive
1	R12 085 145	R11 737 173	13 044 884
2	R151 154	R146 170	R186 496
3	R407 548	R402 668	R437 866
4	R646 152	R642 137	R681 001
5	R872 856	R863 784	R913 990
6	R553 290	R548 542	R573 557
7	R494 975	R489 748	R523 787
8	R242 038	R239 980	R263 664
9	R260 001	R249 332	R285 204
10	R248 493	R239 081	R266 323
11	R138 495	R135 750	R153 804

Table 11 Effect of labour substitution on indirect household income

Project no	Base case	Plant intensive	Labour intensive
1	R34 741 943	R34 547 196	R35 279 076
2	R452 584	R449 864	R471 876
3	R953 652	R951 940	R964 288
4	R1 719 626	R1 718 217	R1 731 852
5	R2 194 021	R2 190 838	R2 208 453
6	R1 221 401	R1 219 735	R1 228 511
7	R1 160 536	R1 158 702	R1 170 643
8	R867 891	R866 770	R879 669
9	R726 254	R720 442	R739 980
10	R700 825	R695 699	R710 536
11	R362 353	R360 817	R370 921

These activities require the use of light machinery and/or hand-held equipment.

Two additional cases were investigated in the sensitivity analysis. These are a plant-intensive case and a labour-intensive case. In the plant-intensive case all the applicable cost items in the eleven bills of quantities are disaggregated into 5 % labour and 95 % plant by cost. For the labour-intensive case all the applicable cost items are disaggregated into 20 % labour and 80 % plant by cost. Moving outside of this range for these projects was not considered realistic because further deviation from the base case would start impacting on time-related and supervision costs. The effect on duration and contract price is not known for any of these projects and that specific impact could not be assessed.

The results of the sensitivity analysis are discussed separately for each of the macroeconomic variables.

Table 8 shows that the GDP multiplier of the projects increased as the proportion of labour increased. It can be seen that substituting labour for plant increased the size of the multiplier. The table shows that for all eleven projects, the difference in the total wage bills between the base case and the plant intensive case was 6,3 %, while the decrease in the GDP multiplier was 0,6 %. The difference in the total wage bill between the base case and the plant intensive case was 19,1 %, while the increase in the GDP multiplier was 2,6 %. The increase in the GDP multiplier is shown graphically in figure 1.

The plant-intensive case has a higher proportion of spending in the SIC category 'machinery and equipment renting and leasing' than the labour-intensive case. The GDP multiplier coefficient for this category is 1,17, which is lower than the average multiplier for the labour spending categories. The labour spending multipliers vary between 1,41 and 1,59, depending on the earning category and the province where the road is located. It therefore stands to reason that the higher the proportion of spending in the labour categories compared to the 'machinery and equipment renting and leasing' category (assuming all other factors remain constant) the higher the GDP multiplier.

Table 9 shows the number of indirect jobs generated for each project. As with the GDP multiplier the number of indirect jobs falls with more plant-intensive techniques and rises with more labour-intensive methods. As mentioned above, these indirect jobs are not the direct jobs created on site but the indirect jobs created through the multiplier effect in the economy. The table indicates that as the proportion of labour is increased, so the number of indirect jobs increased. Also, the cost to create an indirect job decreases as the labour content on site increases. The difference in costs to create one indirect job is 1,1 % between the base case and the plant-intensive case and –3,4 % between the base case and the labour-intensive case.

Table 10 shows the effect of labour substitution on the contribution to taxes. A common trend across all the projects is the increase in the contribution to taxes when the labour component increases. The increased personal tax paid by labour is the prime reason for this.

Table 11 shows that the contribution to indirect household income increases as the labour component increases. As with the other macro impacts the same trends emerge although the actual changes are small.

The data in tables 8 to 11 show that substituting labour for machinery has a positive macroeconomic effect. With an increasing labour component there is an increase in each of the national multiplier, the number of indirect jobs created, the contribution to taxes and a slight increase in the contribution to indirect household income.

CONCLUSION

Roads are an integral part of the infrastructure that is necessary for economic growth. Labour-intensive construction methods are a useful way to further the skills development within a region. If the fundamentals are in place, the use of labour-intensive construction will produce positive results that benefit the community and lead to poverty alleviation.

The paper had two objectives. To determine the overall multiplied impact of road construction in rural underdeveloped areas in South Africa and to determine the macroeconomic impact of marginal changes in the use of labour and plant in road construction. It was found that the GDP multiplier ranged between 1,34 and 1,53 with an average of 1,45. The cost of creating an indirect job ranged from R95 250 to R145 972 with an average cost of R113 835. It was also found that as the proportion of labour increases relative to plant, so too do the benefits to the community and the country.

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